REMARKS

In the Office Action, dated October 30, 2003, the Examiner states that Claims 1-21 are pending, Claims 1-20 are rejected and Claim 21 is withdrawn from consideration. By the present Amendment, Applicant amends the specification and the claims.

With the Office Action, Applicant received an initialed copy of the Form PTO-1449 submitted with the Information Disclosure Statement (IDS) dated October 4, 2001. However, Applicant has not received an initialed copy of the Form PTO-1449 submitted with the IDS dated September 11, 2003. The Applicant requests that an initialed copy be returned with the next communication. If the Examiner needs another copy of this IDS, the Examiner is invited to contact the undersigned attorney.

The Applicant affirms the election to Claims 1-20 without traverse.

In the Office Action, Claims 1-4, 7-12, 14, 16, 17 and 19 are rejected under 35 U.S.C. §102(b) as being anticipated by Bjork et al. (US 4,626,652). Claims 1-4, 7-12, 14, 16, 17 and 19-20 are rejected under 35 U.S.C. §103(a) as being unpatentable over Bjork et al. Claims 1, 3, 4, 6 and 17 are rejected under 35 U.S.C. §102(b) as anticipated by Burns et al. (US 5,259,061). Claims 1, 3, 4, 12, 13, 16, 17 and 19 are rejected under 35 U.S.C. §102(b) as anticipated by Archambault et al. Claims 1, 3, 4, 9 and 17 are rejected under 35 U.S.C. §102(b) as anticipated by O'Brian et al. (US 5,059,763). Claims 1, 3-6, 9 and 17 are rejected under 35 U.S.C. §103(a) as being unpatentable over Burns et al. or O'Brian et al. in view of Chang et al. (US 5,393,371). Claims 1-4, 16, 17 and 19 are rejected under 35 U.S.C. §102(b) as anticipated by Allen et al. (US 5,500,913). Claims 1-4, 7-17 and 19 are rejected under 35 U.S.C. §103(a) as unpatentable over Jain et al. (US 6,221,565) in view of Allen et al. or Bjork et al. Claims 1, 3, 9, 17 and 19 are rejected under 35 U.S.C. §102(b) as anticipated by Tsunemoto et al. (EP 0838701). Claims 1, 3, 7-10, 17 and 19 are rejected under 35 U.S.C. §102(b) as anticipated by Jelley et al. (US 5,368,900). Claims 1, 3, 4, 12, 13 and 15-17 are rejected under 35 U.S.C. §102(b) as anticipated by Bryon (US 4,793,680). Claims 1, 3, 4, 7-11 and 17 are rejected

under 35 U.S.C. §102(b) as anticipated by Man et al. (US 5,039,186). Claims 1, 3, 4, 7, 8, 15 and 17 are rejected under 35 U.S.C. §102(b) as anticipated by Chiang et al. (US 5,106,211). Claims 1, 3, 4, 12, 13, 16, 17 and 19 are rejected under 35 U.S.C. §102(b) as anticipated by Cullen (US 5,708,740). Claims 1-4, 7-12, 14 and 16-20 are rejected under 35 U.S.C. §103(a) as being unpatentable over either Bjork et al., Jelley et al., Chiang et al. or Allen et al., in view of Lin (US 6,263,879). The Applicant respectfully considers that these rejections have been overcome by the amendments to the claims.

The Applicant has also amended the Summary of the Invention in view of the amended claims, and to correct a typographical error on page 6. No new matter has been added by these amendments.

In paragraph 9, Bjork *et al.* (US 4,626,652) is cited against the novelty of Claims 1 to 4, 7 to 12, 14, 16, 17 and 19. The rejection contends that Bjork *et al.* describe the laser ablation of the silica fiber, followed by the evaporation of a thin metal layer to form a polarizer.

Lodged herewith is an amended claim set, in which Caims 1, 3 to 11 and 15 to 21 are amended and new Claims 22 to 25 are added. Claim 1 as amended may be summarized as defining: selecting an optical characteristic of the waveguide and a desired value or property of that characteristic, ablating a service of the optical device without ablating the core of the waveguide, and controlling the ablating of the surface so that the selected optical characteristic is modified so as to assume the desired value or property. Embodiments of this method may most clearly be seen in Figures 2 and 8.

Bjork *et al.* disclose neither ablating an optical device to change an optical characteristic of a waveguide core incorporated in the device, without ablating the core itself, nor controlling the ablation so that a selected optical characteristic of the incorporated waveguide core assumes a desired value or property. Indeed, Bjork *et al.* merely disclose the ablation of the cladding of an optical fiber, so that one can form optical couplers or polarizers. There is no disclosure that one can controllably modify a characteristic of the waveguide core by ablating "an optical device" containing the waveguide.

In fact Bjork *et al.* teach against doing so, as they teach that one should monitor a beam transmitted along the core of the fiber to detect "near exposure of the fiber core" [Abstract]. As is explained from column 3 line 47: "Once core 22 is nearly exposed a sharp decrease will occur in the electromagnetic energy irradiating detector 28 due to an increase in the electromagnetic energy lost at this point. A feedback signal can be transmitted from power meter 30 along line 44 to laser 34 to shut laser 34 off when the core is nearly exposed at point 32, or a short time thereafter to allow completion of a scan which would nearly expose a desired length of core 22." Thus, there is clear teaching against modifying the characteristics of the fiber core, yet that is precisely what one endeavors to achieve according to the present invention.

The present invention thus exploits the inventors' discovery that desirable changes to core characteristics can be effected by ablating the optical device in which the waveguide is provided, which is contrary to the teaching of Bjork *et al.* who teach away from any change in core characteristics. It is submitted, therefore, that the amended claims are clearly novel over the disclosure of Bjork *et al.*

The rejection implies that Bjork *et al.* disclose modifying the birefringent properties of the waveguide, but it is submitted that in fact Bjork *et al.* make no reference to the birefringent properties of a waveguide, or to a method of modifying those properties. It is submitted, therefore, that Claim 3 of the amended claim set is novel over the disclosure of Bjork *et al.* Similarly, Claim 4 defines that the birefringent properties are modified such that the TM and TE birefringent modes are substantially aligned: it is submitted that Bjork *et al.* make not disclosure of performing this method, let alone by the approach defined in Claim 1 as amended. Further, comparable comments apply to the other references discussed below, none of which teach modifying the birefringent properties of the waveguide by the method of Claim 1, nor to the substantial alignment of the TM and TE birefringent modes. It is submitted, therefore, that Claims 3 and 4 are novel over the various cited references.

The rejection contends that Claim 10 is anticipated by Bjork *et al.* Claim 10, however, discloses the step of depositing a material layer on the surface of the

optical device as an electrode for electrically contacting the optical device. It is submitted that there is in fact no disclosure in Bjork *et al.* of such a process. Further, it is submitted that the feature of claim 11—comprising mounting a further component comprising a modulator for modulating a characteristic of the optical device in a groove formed in a surface as a result of the ablating of the surface—is no way disclosed by Bjork *et al.*

In addition, although Claim 21 is unelected, it is submitted that Claim 21 as amended—which defines an optical device incorporating a waveguide processed by the method of Claim 1 as amended—is novel over the disclosure of Bjork *et al.*

In paragraph 10, Claims 1 to 4, 7 to 12, 14, 16, 17, 19 and 20 are rejected as unpatentable over Bjork *et al.* It is submitted, however, that Claim 1 as amended (and hence Claims 2 to 4, 7 to 12, 14, 16, 17, 19 and 20—and indeed Claim 21) define methods that, in view of the distinguishing features of the present invention as defined in the amended claims and discussed above, are non-obvious over the cited reference.

In paragraph 11, Claims 1, 3, 4, 6 and 17 are rejected as anticipated by Burns *et al.* (US 5,259,061). This reference discloses manufacturing an optical waveguide device by tuning the output phase angle of such devices to a desired operating point. This tuning is effected by adjusting the accumulated phase along a waveguide arm of the device by removing optical waveguide material using laser ablation.

However, as the Abstract of this reference explains, the optical phase velocity is changed owing to "the change in waveguide geometry in the ablated region"; consequently the optical path length is affected *in the ablated section* of waveguide, thereby resulting in a change in output phase angle. Burns *et al.* therefore teach that one should modify certain properties by ablating the waveguide where the modification is desired, contrary to the method of the present invention in which characteristics of the core are modified without ablating the core. Thus, from column 3 line 1, Burns *et al.* teach that: "Shaping of the ablating laser beam geometry by the use of precision shutters 36, to a micrometer or less, permits precise positioning of the ablating laser beam 42 on the waveguide section 54 to be ablated. Variation of

the ablating laser 42 energy/pulse permits the removal of a very small amount of the optical waveguide 54". This is depicted, for example, in Figure 2, in which the location of waveguide section 54 relative to single-mode channel optical waveguide 46 is shown.

It is submitted, therefore, that Claim 1 as amended and claims depending therefrom are novel the disclosure of Burns *et al.*

In paragraph 12, Claims 1, 3, 4, 12, 13, 16, 17 and 19 are rejected as anticipated by Archambault *et al.* The Examiner explains that this reference discloses the use of excimer lasers to ablatively write gratings into optical fibers, and that an optical fiber is regarded as an optical device.

However, this reference fails to disclose the ablation of a surface of such optical fibers without ablation of the core of a waveguide contained therein, such that an optical characteristic of the core is modified. Indeed, this reference explicitly refers to focussing two laser beams into the core of the fiber (see page 28, first paragraph of "Experiment"), and no reference is made to ablating a surface of the optical device in the form of the optical fiber. In general terms, Archambault *et al.* teach directly modifying the optical characteristics of a waveguide by focussing laser beams into the core. This is entirely unlike the approach of the present invention, in which merely the surface of the optical device is ablated, but no ablation is performed on the core itself.

It is submitted, therefore, that Claim 1 as amended and claims depending therefrom are novel over the disclosure of Archambault *et al.*

In paragraph 13, Claims 1, 3, 4, 9 and 17 are rejected as anticipated by O'Brian *et al.* (US 5,059,763). This reference discloses a method of forming optical quality surfaces in optical material, including the laser etching and the subsequent removal of the resultant slag. The resultant grooves are used to couple optical fibers to waveguides.

However, this reference merely discloses a method of using laser ablation for producing optically flatter surfaces, to optimize the aforementioned coupling of optical fibers and waveguides. There is no disclosure of the method of claim 1 as

amended, in which a selected characteristic of a waveguide core is modified by ablating a surface of an optical device incorporating that waveguide.

It is submitted, therefore, that Claim 1 as amended and claims depending therefrom are novel over the disclosure of O'Brian *et al.*

Concerning Claims 3 and 4: O'Brian *et al.* does discuss the birefringent properties of optical materials, but only to explain the difficulties experienced using etching to effect adequate coupling of one to another. Thus, from column 1 line 48, this reference explains that: "The chemically inert nature of most birefringent crystals greatly complicates the coupling problem. A suitable etchant has not been found for lithium niobate, which removes crystal material adjacent the waveguide end face in a rapid and precise manner to form a support structure for maintaining the optical fiber in a fixed positioned abutting the end face. In particular, lithium niobate and other like materials are highly resistant to chemical or plasma etching." Thus, the general submission above on Claims 3 and 4—that none of the cited references disclosure the present invention as defined in Claims 3 and 4—also applies to this reference.

In paragraph 14, Claims 1, 3 to 6, 9 and 17 as unpatentable over either Burns *et al.* or O'Brian *et al.* in view of Chang *et al.* (US 5,059,763).

The rejection contends that Chang *et al.* disclose the use of a metallic layer to act as a mask to prevent melting of adjacent layers. However, even if this is so, and even if the skilled person were to combine these respective disclosures, these combinations still fail to disclose or to in any way suggest all the features of the present invention as defined in Claim 1 as amended. The Examiner is referred to the above remarks on the disclosures of Burns *et al.* and O'Brian *et al.*

In particular, even if Chang *et al.* disclose a method of limiting the effects of ablation, the cited combination of references fails to disclose the steps of the present invention in which ablation is not merely limited in spatial extent (as taught by Chang *et al.*), but controlled so that a selected optical characteristic of a waveguide core provided in the optical device is modified to assume a desired value or property.

It is submitted that Claims 1, 3 to 6, 9 and 17 as amended are non-obvious over the cited combinations of references.

In paragraph 15 the Examiner rejects Claims 1 to 4, 16, 17 and 19 as anticipated by Allen *et al.* (US 5,500,913).

Allen *et al.* describes the use of a laser to ablate the cladding of an optical fiber in order to fabricate an optical fiber tap (see, for example, column 6 lines 1 to 14). However, Allen *et al.* make no disclosure of, or in any way suggest, the method of the present invention in which ablating a surface of the optical device—though without ablating the core of the incorporated waveguide—is controlled in order to modify a selected optical characteristic of the *core* so as to assume a desired value or property.

It is submitted, therefore, that Claim 1 as amended and claims depending therefrom are novel over this reference.

In paragraph 16, Claims 1 to 4, 7 to 17 and 19 are rejected as unpatentable over Jain *et al.* (US 6,221,565) in view of either Allen *et al.* or Bjork *et al.* The rejection contends that it would have been obvious to use the laser etching disclosed by Jain *et al.* in the disclosures of Allen *et al.* or Bjork *et al.*

However, while Jain *et al.* may disclose various forms of etching (cf. column 9 line 37), they make no reference to ablation and so, even when combined with the disclosures of Allen *et al.* or Bjork *et al.*, the cited references in no way suggest the method of Claim 1 as amended in which ablation of a surface of an optical device is used to modify an optical property of the core of a waveguide incorporated in that device. Indeed, combining the disclosure of Jain *et al.* adds no more than the technique of laser etching to the disclosures of Allen *et al.* or Bjork *et al.* so, as will be appreciated in the light of the above comments concerning the disclosures of Allen *et al.* and Bjork *et al.*, the combined disclosures in no way render obvious the present invention.

It is submitted, therefore, that Claim 1 as amended and claims depending therefrom are patentable over the cited combination of references.

In paragraph 17, Claims 1, 3, 9, 17 and 19 are rejected as anticipated by Tsunemoto *et al.* (EP 0838701). Tsunemoto *et al.* provide yet another disclosure of a laser ablation method, in this instance for forming a hole for accommodating an optical fiber at the core of an optical waveguide. However, as is particularly

apparent from figure 6 of this reference, ablation occurs all the way to—and including—the core of the waveguide. This is contrary to the method of the present invention as defined in Claim 1 as amended, in which ablation of a surface of an optical device is effected, without ablation of the core of an incorporated waveguide.

Further, Tsunemoto *et al.* in no way teach nor suggest that any method comparable to that of the present invention—in which the waveguide core is not itself ablated—can be used to modify a selected optical characteristic of the core so as to assume a desired value or property.

Accordingly, it is submitted that Claim 1 as amended and claims depending therefrom are novel over the cited reference.

In paragraph 18, Claims 1, 3, 7 to 10, 17 and 19 as fully anticipated by Jelley *et al.* (US 5,368,900).

However, as is explained from column 3 line 17, Jelley *et al.* teach that a waveguide 14 carried on a generally planar substrate 12 (see figure 6) be ablated until an oblique surface 62 is formed, for subsequent coating to form a mirror. As will be appreciated from the above comments, the direct ablation of the waveguide core is contrary to the present invention as defined in Claim 1 as amended, which defines the ablation of a surface of an optical device *without* the ablation of the core of an incorporated waveguide, to modify a selected optical characteristic of the core itself.

Accordingly, it is submitted that Claim 1 as amended and claims depending therefrom are novel over the cited reference.

In paragraph 19, Claims 1, 3, 4, 12, 13 and 15 to 17 as fully anticipated by Byron (US 4,793,680).

Byron teaches the exposure of the surface of an optical fiber to a focused laser beam so that, owing to interference effects, ripples and hence a grating are formed "on the outer surface of an optical waveguide" [Abstract].

Claim 1 of the present application, however, defines controlling the ablation so as to modify an optical characteristic of the core of a waveguide incorporated in an optical device, so as to assume a desired value or property. Byron in no way suggests this approach, since he explicitly teaches effecting the outer surface of the

waveguide. There is no suggestion of controllably ablating a surface so as to effect a modification in the core of an incorporated waveguide.

Indeed, Byron makes no reference to ablation (of a surface of an optical device or otherwise) so it is clear that Byron in no way teaches or suggests controllably ablating a surface to affect modification of an optical characteristic of an incorporated waveguide's core. This must surely be so, even if ablation were regarded as implicit in the disclosure of Byron

It is submitted, therefore, that Claim 1 as amended and claims depending therefrom are novel over the disclosure of this reference.

In paragraph 20, Claims 1, 3, 4, 7 to 11 and 17 are rejected as anticipated by Man *et al.* (US 5,039,186).

The rejection contends that Man *et al.* teach (cf. figure 3a) the ablation of a cladding layer 26 copolymer are followed by the addition of a smoothing layer and an electrode layer.

From column 11 line 11 it is explained that, in one variation, an excimer laser is imaged onto the upper surface of cladding layer 26, thereby ablating the polymer in the regions exposed to the laser beam to form a 10 μm wide well in cladding layer 26 in the shape of the type electrode. However, there is no disclosure that this procedure leads to any result other than the creation of a well for accommodating an electrode. There is no suggestion or teaching that the laser ablation is controlled in order to modify an optical characteristic of the waveguide 25 so that the characteristic assumes a desired value or property.

It is submitted, therefore, that Claim 1 as amended and claims depending therefrom are novel over the disclosure of Man *et al.*

In paragraph 21, Claims 1, 3, 4, 7, 8, 15 and 17 are rejected as anticipated by Chiang *et al.* (US 5,106,211).

Chiang *et al.* disclose the use of an excimer laser to ablate a laminated matrix 10 to form channels 16 and 17 (see column 7 lines 60 to 68). Laminated matrix 10 comprises co-polymer film 12, waveguiding layer 13 and co-polymer film 14. This process is illustrated in figure 1B, with a comparable example shown in figure 2C.

However, as is clear from the above summary, the process taught by Chiang *et al.* includes more than merely ablating the surface of an optical device; in fact entire channels of waveguide material are removed, including any core. Thus, Chiang *et al.* teach away from the present invention, in which only a surface of an optical device is ablated, without ablating the core of an incorporated waveguide.

In addition, Chiang *et al.* in no way suggest performing such an ablation so as to modify a selected optical characteristic of the waveguide to as to assume a desired value or property. The ablation of Chiang *et al.* is conducted in order to form channel waveguides by *removing* sections of waveguide, not to modify an optical characteristic of the core of an existing waveguide.

It is submitted, therefore, that Claim 1 as amended and claims depending therefrom are novel over the disclosure of the cited reference.

In paragraph 22, Claims 1, 3, 4, 12, 13, 16, 17 and 19 are rejected as fully anticipated by Cullen (US 5,708,740).

Cullen teaches a two stage process. Firstly, a laser is used to ablate material from the side of a circularly symmetric optical fiber (see column 3 lines 56 to 60), in order to add notches (11) to the side of the fiber. This is explained from column 3 lines 60: "the notches (11) are *not deep enough to reach the core* 12 of the fiber 10, and so the effective refractive index of the fiber is substantially unchanged by the cutting of the notches 11. Accordingly, the cutting of the notch does not of itself induce any appreciable core/cladding mode coupling" [emphasis added].

Secondly, the fiber is locally heat softened in the vicinity of each notch so that each notch 11 is smooth-out to form a wasted region 13 of substantially circularly symmetric profile. As is explained from column 4 line 3: "in the course of this smoothing-out process a wrinkle 14 is formed in the core".

Thus it is clear from these passages that the laser ablation is used merely to create the notches in the cladding, *not* to in any way affect the core. Indeed, Cullen teaches away from affecting the core, by laser ablation, in any way.

In any event, there is also clearly no teaching in Cullen of controllably ablating a surface, though without ablating the core of an incorporated waveguide, in order to

modify a selected optical characteristic of the core so as to assume a desired value or property.

It is submitted, therefore, that Claim 1 as amended and claims depending therefrom are novel over the disclosure of Cullen.

In paragraph 23, Claim 1 to 4, 7 to 12, 14 and 16 to 20 are rejected as unpatentable over either Bjork *et al.*, Jelley *et al.*, Chiang *et al.* or Allen *et al.*, in view of Lin (US 6,263,879).

The rejection contends that Lin teaches the functional equivalence of laser diode laser, excimer lasers, YAG laser and carbon dioxide lasers in laser etching optical components. The rejection contends that it would therefore have been obvious to one skilled in the art to modify the processes of the other references by using other types of laser with a reasonable expectation of success, based on the disclosure of Lin.

However, even if these references were combined in a manner suggested by the rejection, the result in combination would still fail to disclose the present invention as defined in claim 1 as amended. As is discussed above, none of Bjork *et al.*, Jelley *et al.*, Chiang *et al.* and Allen *et al.* discloses ablating a surface of an optical device so as to modify an optical property of an incorporated waveguide's core without ablating the core itself, so that the optical characteristic assumes a desired value or property. This is not made good by Lin, whose relevance--according to the rejection—merely concerns the functional equivalence of different types of lasers.

It is submitted, therefore, that the present invention as defined Claim 1 as amended and claims depending therefrom is non-obvious on light of these combinations of references.

In light of the foregoing response, all the outstanding objections and rejections have been overcome. Applicant respectfully submits that this application should now be in better condition for allowance and respectfully requests favorable consideration.

Respectfully submitted,

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Date

Attorney for Applicant
Brian W. Hameder
c/o Ladas & Parry
224 South Michigan Avenue
Chicago, Illinois 60604
(312) 427-1300
Reg. No. 45613